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Full Length Research Paper

Milk Production Performance of Red Chittagong Cattle Based on Phenotypic and Genetic Parameters

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This study was conducted to investigate the milk production performances of Red Chittagaong Cattle (RCC) *in-situ* and *ex-situ* condition and to estimate the genetic parameters of milk yield traits of RCC. Data on a total of 237 RCC cows and heifers from five different herds (Anwara, Chandanaish, Potiya, Raojan and Satkania in Chittagong district) and 153 cows and heifers from Nucleus Herd maintained at the Research Farm of Bangladesh Livestock Research Institute (BLRI) covering a period from 2008 to 2011 were used. Data were analyzed by Generalized Linear Model (GLM) to find out the least squares means and least significant differences. Results: The least squares mean of lactation length (LL), lactation milk yield (LMY) and daily milk yield (DMY) were 205.65±1.711 days, 455.53±9.127 kg and 2.20±0.037 kg in *in-situ*, and 204.79±5.49 days, 702.35±25.53 kg and 3.40±0.75 kg in *ex-situ*, respectively. Calving parity, herd, year, season and interaction effect of herd-year-season were not significant for LL, but had highly significant effects on LMY and DMY. Genetic parameters were estimated by Residual Maximum Likelihood (REML) procedure using animal model. The heritability of milk yield traits was medium (0.23±0.05 to 0.34±0.06) except for LL which was very low (0.04±0.05). The phenotypic and genetic correlations of LL with LMY and DMY were 0.63±0.06, 0.81±0.13, 0.12±0.06 and 0.99±0.14, respectively. LL had significant and positive phenotypic correlations with LMY ($p<0.01$) and DMY ($p<0.05$). The phenotypic and genetic correlations between LMY and DMY were 0.83±0.06 and 0.73±0.12, respectively. LMY had highly significant ($p<0.01$) and positive phenotypic correlation with DMY. Considering the performance potential of RCC both in *in-situ* and *ex-situ* through community farmers' participatory approaches there may be chance of improvement of genetic potentiality of RCC as indicated by their phenotypic variations and values of genetic parameters.

Keywords: Red Chittagong Cattle, Phenotypic performance, Genetic parameters, Milk yield

INTRODUCTION

Red Chittagong Cattle (RCC) is newly discovered indigenous cattle genetic resource of Bangladesh found in greater Chittagong and peripheral regions with some distinct characteristics made them more preferable and popular for their good quality milk, meat, adaptability with low input feeding and management, more disease resistance and regular yearly calving to our prevailing hot and humid climatic conditions. But this variety of cattle is

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under the threat of extinction due to rapid expansion of crossbreeding throughout the country for enhancing immediate milk and meat production. In case of dairy industry milk production traits are directly associated with the profitability of the farm or farmers because demands for higher milk yields with more calves are highly expected from an individual cow's life. However, it depends largely on the genetic potentialities of their ancestors. Profitable breeding could be achieved by keeping lactation length, dry period and service period between optimal limits (Alpan, 1994; Kumuk et al., 1999; Cilek and Tekin, 2005; Kocak et al., 2007). It is generally said that the yields of farm animals are the combined effects of genotype and environment (G×E). In order to let individual to express their full genetic potentiality, it is necessary to optimize the environmental effects within the limits. Environmental factors can be classified as factors with measurable effects such as age, year, season, milking frequency etc, and factors with immeasurable effects such as diseases, management, feeding status etc.

Although information on accurate milk production performance of exotic and crossbred cows are somewhat available for commercial farming condition in Bangladesh, but are not clearly available for indigenous cattle, because indigenous cattle has not yet been reared commercially in groups. Very little information on this type of cattle have so far been accumulated and studied from some domestic and foreign aided short term research projects implemented by University and research institute. Thus, a comprehensive study on milk production traits of indigenous cattle is essential for improving the breeding efficiency and formulating breeding strategy. It is also an important tool of a breeder to evaluate the factors affecting the milk production traits of indigenous cattle of Bangladesh. Considering the aforementioned circumstances, the present study was conducted with a view to know the phenotypic and potentiality of RCC in *in-situ* and *ex-situ* farm management condition in Bangladesh.

MATERIALS AND METHODS

Place of the study

This study was conducted taking data from two locations; *in-situ* and *ex-situ*. The data in *in-situ* were collected from RCC herd maintained at five upazilas in Chittagong district namely: Anwara, Chandanaish, Potiya, Raojan and Satkania and data in *ex-situ* were collected from the RCC herd maintained at Research Farm of Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka.

Topography and climate of the study areas

Red Chittagong Cattle (RCC) is primarily found in the Chittagong district of Bangladesh which belongs to Agro-ecological Zone-23 (AEZ-23) of Bangladesh, situated at the south east part of the country. The area is bordered with a long coastal belt and stands on its western side with scenic blending of hills, valleys and coastal plain. Chittagong District lies in the 21°54′ - 22°59′ north latitude and 91°17′- 92°13′ east longitude with an area of 5,282.98 sq. km of which 561.98 sq. km riverine area, 1182.43 sq. km forest area and the rest 3,538.57 sq. km hilly and plain land area. The climate of the region is tropical in nature. The lowest and highest temperature varied from 14° in winter to 34°C in summer. Humidity was found to be around 85% from September through December and around 72% from September through February. High humidity and heavy rainfall of about 1900 millimeters annually is mostly recorded from May to October.

The *ex-situ* herd which was maintained at the Research Farm of Bangladesh Livestock Research Institute (BLRI) located at Savar, an upazila of Dhaka district and belongs to AEZ-28 of Bangladesh. It is located at a distance of about 28 km to the northwest of Dhaka city and lies between 23.8583º North latitude to 90.2667º East longitude. Savar upazila has an area of 280.13 km². It has a distinct monsoonal season, with an average annual temperature of 25ºC (71ºF) and monthly means varying between 18ºC (64.4ºF) in January and 32ºC (71ºF) in May. Approximately 87% of the annual average rainfall of 2,123 millimeters (83.5 inch) occurs between May and October. The land of the Savar upazila is composed of alluvium soil of the pleistocene period. The height of the land gradually increases from east to the west. The southern part of the upazila is composed of the alluvium soil of the Bangshi and Dhalashwari rivers.

Feeding and management

In the *ex-situ* conservation, the animals were intensively managed in research farm of Bangladesh Livestock Research Institute. Stall feeding was the main feature of feeding through limited grazing from 10 a.m. to 12 noon daily. They were fed two times at 7 to 8 a.m. and 3 to 4 p.m. Concentrate supplied was 1% of the body weight of the animals. Silage and green grass were supplied *ad lib*. FMD vaccines applied two times a year with interval of six months, Anthrax and BQ vaccines were applied as per method prescribed by Department of Livestock Services. Deworming was done at a regular interval. All the cows and heifers were bred by RCC bulls. In the *in situ* herd animals were reared mostly extensively in day time through grazing. Very little amount of concentrates was supplied to the animals. Vaccination and deworming were applied seldom.

Animals and data

The animal selection program was conducted with close linkage with BLRI and Central Artificial Insemination Laboratory (CAIL), Savar under Central Cattle Breeding and Dairy Farm. The productive performances of *RCC in-situ* in five selected Upazilas and *ex-situ* was studied in RCC breeding herd of Bangladesh Livestock Research Institute (BLRI) Research farm. The RCC herd at BLRI Farm was considered as Nucleus herd. The best bulls of nucleus herd were transferred to the CAIL. Semen from these bulls were collected, evaluated and distributed to the community for insemination. The best performing females and bulls available in different community were selected and gradually transferred to the nucleus herd maintained at BLRI research farm. Thus a continuous process of selection and transfer activities were established. In the *ex-situ* study, a total of 49 cows of different ages were selected. Data on milk production traits of cows reared *ex-situ* were recorded daily through a registered book where the researchers recorded the information of individual animal. The milk production data contained lactation length, lactation yield and daily milk yield those were collected from July 2009 to June 2011.

Statistical model and data analyses

Animals were arranged in contemporary groups, based on herd-year-season and lactation parity. Initially, the general linear model (GLM) procedure of SPSS 16 was used to adjust all fixed effects as well as to test all possible linear models. Least significance difference (LSD) [3] and Duncan's multiple range test (DMRT) by [4] were used for mean comparisons.

$Y_{ijkl} = \mu + H_i + N_k + R_l + \mathbf{e}_{ijkl}$

Where, Y_{ijkl} = Observed milk production traits (LL, LMY, DMY)

μ = Overall population mean for the said trait,

H_i = Fixed effects of i^{th} herd (where i = Site-1, Site-2, Site-3, Site 4 and Site-5 for *in-situ* and Site-6 for *ex-situ*),

P_j = Fixed effects of j^{th} lactation parity (where j = 1, 2 ...and 6+),

N_k = Fixed effects of k^{th} calving season (where k = summer, rainy, winter),

R_l = Fixed effects of l^{th} calving year (where m = 2008, 2009,….. 2012),

$\mathbf{e}_{ijkl}$ = Random sampling error associated with Y_{ijkl} observation

Estimation of genetic parameters

For genetic analyses, (co)variance components of each trait were estimated applying Residual Maximum Likelihood (REML) approach by VCE 4.2.5 computer package [5]. For REML analysis, animal model was used considering herd-year-season and lactation parity as fixed effects. The general animal model was of the form:

$Y = Xb + Za + WC + e$

Where, Y = Vector of observations

X, Z, and W = Known incidence matrices associated with levels of b, a and c with Y.

b = Unknown vector of fixed effects (i.e. sex, herd, year, season, parity, age)

a = Unknown vector of breeding value

c = Unknown vector of permanent environmental effects

e = Vector of residual effect

The analyses covered estimation of (co)variance components and genetic parameters which included heritability and genetic correlation between traits. For estimating variance components and genetic correlations between paired traits, multi-trait animal model was used by VCE 4.2.5 [5] (Groeneveld, 1998) with REML method. Phenotypic correlations with bi-variate analyses among milk yield traits were estimated by Pearson's product moment correlation using SPSS 16.0.

RESULTS AND DISCUSSION

Lactation length (LL)

The least squares mean along with standard error (SE) of milk production traits of RCC are depicted in Table 1. The mean lactation length of RCC cows estimated from in situ and ex situ herds were 205.72±3.24 days (Table 1), which was closely in the line of earlier studies of Bag et al. (2010), Azizunnesa et al. (2010), Alam et al. (2007), Hossain et al. (2006), Munim et al. (2006) and Khan et al. (1999) for the same genotype who reported it from 208.08±3.11 to 242.2±8.3 days. However, longer durations of lactation were also reported by Habib et al. (2003 and 2010) for the same genotype in an ex-situ nucleus herd in their studies (261.1±14.5 and 259.6±6.2days, respectively). Their findings were not consistent with this study. The variations of lactation length within same genotype among different herds reported by different authors might be due to animals of different genetic constituents or origin, feeding, management, environments, sample size etc.

Statistical analyses showed no significant (p>0.05) variation of lactation length for different calving parities. This is in consistent with the findings of others (Habib et al., 2003, 2010 for RCC; Cilek and Tekin, 2005; Zafar et al., 2008; Kocak et al., 2007 for other breeds) who found no significant variation of lactation duration due to age or calving parity. But this result is not consistent by Cilek (2009), Ilatsia et al. (2007), Parra-Bracamonte et al. (2005) and Ageeb and Hillers (1991a) who found significant effects (p<0.001-p<0.05) of lactation duration for order of lactations/calving age. The variations might be due to

Table (1): Least squares means (±SE) of lactation length, total lactation yield and daily milk yield as affected by various factors

Factors[1]	Least squares means (±SE) of milk yield traits		
	Lactation length (days)	Total lactation yield (kg)	Daily milk yield (kg)
Parity	NS	***	***
1	188.58±7.71 (029)	453.26^{c}±33.98 (029)	2.37^{b}±0.11 (029)
2	202.14±4.43 (104)	565.88^{c}±19.51 (104)	2.79^{b}±0.06 (104)
3	211.30±5.27 (069)	630.41^{c}±23.23 (069)	3.00^{b}±0.08 (069)
4	212.09±7.22 (032)	662.56^{bc}±31.83 (032)	3.13^{b}±0.10 (032)
5	203.15±12.3 (010)	593.50^{c}±54.15 (010)	2.90^{b}±0.18 (010)
6	212.06±9.54 (017)	624.57^{ab}±42.02 (017)	2.94^{a}±0.14 (017)
7+	210.70±8.09 (022)	645.03^{a}±35.66 (022)	2.97^{a}±0.12 (022)
Herd	NS	***	***
In situ	204.68±4.14 (187)	441.68^{b}±18.25 (187)	2.13^{b}±0.06 (187)
Ex situ	206.49±4.57 (096)	712.54^{a}±20.13 (096)	3.43^{a}±0.07 (096)
Year	NS	***	**
2008	205.22±5.38 (057)	541.08^{b}±23.70 (057)	2.61^{b}±0.08 (057)
2009	211.40±6.08 (070)	598.92^{b}±26.78 (070)	2.81^{b}±0.09 (070)
2010	196.33±5.22 (129)	536.74^{b}±23.01 (129)	2.74^{b}±0.08 (129)
2011	214.14±7.95 (027)	821.75^{a}±35.03 (027)	3.80^{a}±0.12 (027)
Season	NS	**	*
Summer	200.89±4.40 (127)	576.33^{ab}±19.40 (127)	2.86^{ab}±0.06 (127)
Rainy	202.40±6.04 (062)	562.76^{b}±26.61 (062)	2.74^{b}±0.09 (062)
Winter	213.86±4.97 (094)	650.29^{a}±21.91 (094)	3.02^{a}±0.07 (094)
Herd×Year×Season	NS	*	**
Minimum	47	139	1.20
Maximum	305	1568	6.14
Overall mean	205.72±3.24 (283)	596.46±14.28 (283)	2.87±0.05 (283)

[1]Parity-calving parity; Herd-herd of cow reared; Season-season of calving; Year- year of calving; *- significant at p<0.05; **-significant at p<0.01; ***-significant at p<0.001; NS-non significant (p>0.05); Least squares means without a common superscript in the same column differed significantly (p<0.05); Figures in the parenthesis indicate the number of observations.

different breeds or environment or sample size. The lactation length of RCC did not differ significantly (p<0.05) between herds which agrees well by the study of Agyemang et al. (1991) for N.Dama cattle in Gambia, while not agrees by Parra-Bracamonte et al. (2005) in Mexico and Rehman et al. (2008) in Pakistan as they found significant (p<0.05) difference of lactation length among different herds. The variable results among authors might be resulted due to variation of genetic, environment or population size. There is no significant (p>0.05) difference of lactation length among different calving years which coincides by the recent study of Habib et al. (2010) for this genotype and Wilson et al. (1987) for Kenana breed in Sudan. However, this result is not in agreement with Zafar et al. (2008), Ilatsia et al. (2007), Cilek and Tekin (2005) and Agyemang et al. (1991). The results obtaining variations among authors could be due to different breeds or environment or sample size. Calving season has no significant (p>0.05) effect on lactation length. This result is consonant with the recent work of Habib et al. (2010) for the same genotype. Cilek and Tekin (2005) and Wilson et al. (1987) found no significant variation (p>0.05) of lactation length for calving season which are also accorded by this study. On the other hand, Zafar et al. (2008), Rehman et al. (2008), Ilatsia et al. (2007) and Parra-Bracamonte et al. (2005) reported significant variations of lactation length due to different seasons of calving. Their results are not in agreement by this study that could be due to different breeds or different management systems.

Lactation milk yield (LMY)

The total lactation milk yield taken by test day records from in situ and ex situ herds were calculated by ICAR method which averaged 596.46±14.28 kg (Table 1). Habib (2011) in his recent study in a nucleus herd found total lactation yield of 596.91±21.88 kg which is exactly as like as found in this study for the same genotype. This is also nearly in the line of Munim et al. (2006) for RCC (570.5±112.5 kg.). The result of this study is better than those of others (Habib et al., 2010; Alam et al., 2007; Munim et al., 2006) who found 500.7±19.3, 516.9±35.9 and 528.8±59.8 kg for RCC and Local×Sahiwal crosses. But this performance is comparatively lower than those of Bag et al. (2010), Hossain et al. (2006) and Habib et al. (2003) who got better yields as 805.74±36.52 liters, 805.08±2.07 liters and 661.2±39.8 kg, respectively. The lactation yield of RCC is better than that of Non-descript Desi cows (213.0±9 kg) reported by Hossain and Routledge (1982) and Sanga and Friesian-Sanga crossbred cows (162±12 and 266±12 kg) reported by Darfour-Oduro et al. (2010). The variations of lactation milk yield within and between breeds among different authors could be due to animals of different origin or different genetic back ground, duration of lactation, feeding, management, environments, population size etc.

Statistical analyses revealed that calving parity had highly significantly ($p<0.001$) effect on total lactation milk yield (Table 1). Milk yield gradually increased with increasing calving parity till 4th lactation and then declined later on (Table 1). Habib et al. (2010) in their recent study for the same genotype found increasing yield with progressing lactation order and peaked at 5th lactation and decreased thereafter. Wilson et al. (1987) found yields increased to a maximum at 3rd to 5th lactations and then diminished. Zafar et al. (2008) found lowest milk yield for the first lactation and highest in 6th lactation. Tadesse et al. (2010), Ilatsia et al. (2007) and Parra-Bracamonte et al. (2005) reported significant variations ($p<0.001$-$p<0.05$) of milk yield due to calving age/parity. Their results are closely associated with the result of this study. Significant effect of calving parity on milk production, especially between first and later parities indicates that cows starting lactation at early age are not fully mature and their mammary glands are not fully functional, thus giving less lactation yield compared to the cows which are in the 3rd, 4th, or 5th lactation which are fully mature. But the result of this study contradicts with other published results by Alam et al. (2007), Kocak et al. (2007) and Habib et al. (2003) who noticed no significant ($p>0.05$) effect of calving parity on total lactation milk yields.

Table 1 showed that total lactation milk yield of RCC in two herds differed significantly ($p<0.001$). Total lactation milk yield of RCC cows produced in ex situ herd was significantly higher than those of cows produced milk yield in in situ herd (Table 1). In general agreement, earlier workers studied on it who noticed significant influence of herd on milk yield are Rehman et al. (2008) and Parra-Bracamonte et al. (2005). In contrast, Tadesse et al. (2010) reported no significant variation of milk yield for different herds of Holstein Friesian cows in Ethiopia. The variations of results among workers among different breeds might be due to difference of management and feeding provided by the farmers or different environment and climatic conditions prevailing in those areas.

Total lactation milk yield varied significantly ($p<0.001$) among different years (Table 1) which is concomitant by the recent study on similar type of cows investigated by Habib (2011) in his Ph.D. work in a nucleus herd. However, similar investigations for the effect of calving year ($p<0.001$-$p<0.05$) were also reviewed by Darfour-Oduro et al. (2010) for Sanga and its crosses with Friesian in Ghana, Tadesse et al. (2010) for Holstein Friesian dairy cows in Ethiopia, Zafar et al. (2008) and Rehman et al. (2008) for Sahiwal cattle in Pakistan, Ilatsia et al. (2007) for Sahiwal cattle in Kenya, Parra-Bracamonte et al. (2005) in Mexico and Wilson et al. (1987) for Kenana breed in Sudan. Table 1 shows although an inconsistent but significant trend of milk yield among different years. The variations of total lactation milk yields observed in different periods indicate the effect of management as well as environmental throughout the years. The level of management varies according to the ability of the farm authority, efficiency in the supervision of the staff, system of crop husbandry, method and intensity of culling (Habib, 2011). The highest milk yield observed in the last study period might be due to good nourishment or husbandry practices during that period.

Calving season had highly significant ($p<0.01$) source of variation for total lactation milk yield (Table 1) which could be resulted due to seasonal influences as well as feed, temperature, humidity and management. In accordance with this finding, Zafar et al. (2008), Rehman et al. (2008), Ilatsia et al. (2007), Kocak et al. (2007), Cilek and Tekin (2005), Parra-Bracamonte et al. (2005) and Wilson et al. (1987) had reported the evidence of seasonal influence on milk production. However, Habib (2011), Habib et al. (2010), Tadesse et al. (2010) and Wilson et al. (1987), on contrary reported no significant variation of milk yield for seasonal factor. Season can affect milk production in two ways. First, a deficiency of fodder in a particular season, and secondly, seasonal stress due to extreme temperatures, precipitation and humidity may suppress production at the peak of lactation curve (Habib, 2011). Contradictory reports on seasonal variation on production indicate that those stress factors may be overcome through better feeding and management.

Daily milk yield (DMY)

The average daily milk yield of cows for *in situ* and *ex situ* herds as calculated by the ratio of total milk produced in lactation with lactation duration was 2.87±0.05 kg (Table 1). The mean daily milk yield found by this study is somewhat higher than earlier reports of Habib (2011), Bag *et al.* (2010), Azizunnesa *et al.* (2010) and Khan *et al.* (1999) who found 2.29±0.06 kg, 2.25±1.05 and 2.10±0.63 ltrs, 1.8±0.9 and 2.0±0.7 kg, respectively for the same genotype. Hossain *et al.* (2006), Munim *et al.* (2006) and Habib *et al*. (2003) found daily milk yield ranging from 2.70 to 3.2 kg for RCC in their studies which are closely in the

Table (2): Heritability of milk production traits of RCC

Traits	Variance matrices				h^2± SE
	Additive genetic (σ^2_A)	Environmental (σ^2_{PE})	Residual (σ^2_E)	Phenotypic (σ^2_P)	
Lactation length	48.70	13.86	1278.09	1340.64	0.04±0.05
Lactation milk yield	6668.63	2048.35	19917.72	28634.69	0.23±0.05
Daily milk yield	0.111	0.03	0.180	0.32	0.34±0.06

*h^2 = heritability; SE = standard error of heritability

line of this study. The daily milk yield of RCC was found better as compared to other Non-descript Deshi cows as reported by Bhuiyan and Faruque (1994), Husain and Mostafa (1985), Darfour-Oduro *et al.* (2010) for Sanga and Friesian-Sanga crossbred cows in Ghana (ranging from 1.0 to 1.6±0.7). The variations of daily milk yield among authors might obviously due to animals of different origin, genetic composition, lactation duration, feeding, management, environments, sample size etc. Most importantly, source of data or method of data collection (such as surveyed data or objectively recorded on individual cows) has important factor on the results reported in various studies. A great majority of these in Bangladesh are based on survey based data and hence need to be treated with caution (Habib, 2011).

Daily milk yield differed significantly ($p<0.001$) with calving parity as shown in Table 1. The daily milk yield increased gradually while progressing number of calving, peaked at 4th parity, and declined thereafter with irregular trend (Table 1). Habib (2011) in his recent study on RCC at nucleus herd found highest daily milk yield in 5th lactation and lowest in 1st lactation with significant difference among calving parities which agrees well by this study. This result also in consistent with the findings of Habib *et al.* (2010), Munim *et al.* (2006) and Parra-Bracamonte *et al.* (2005) who found significant ($p<0.05$) effect of parity on daily milk yield in their studies. In contrast, Habib *et al.* (2003) and Ageeb and Hillers (1991a) differed as they found no significant ($p>0.05$) variation of daily milk yield among different calving parities. The variations observed among authors might be due to different management systems or number of population collected for analysis.

This study revealed that daily milk yield depends significantly ($p<0.001$) on different herds (Table 1) which exerts well by the recent finding of Habib (2011) for this factor in the same genotype. Table 1 shows that daily milk yield of RCC produced in *ex situ* is significantly higher ($p<0.001$) than those of cows produced daily milk yield in *in situ* herd. Parra-Bracamonte *et al.* (2005) in their literatures reported significant variation of daily milk yield per lactation in different regions of Mexico which indeed the same finding as found in this study. Actually, the variations of daily milk yield for the same breed in different herds might vary for differentiation of level of nutrition, management and disease conditions provided by the herdsmen (Habib, 2011).

Calving year had highly significant ($p<0.01$) effect on daily milk yield as shown in Table 1 where the daily milk yield in the last studied year had amounted higher than those of previous years. This result differs by Habib (2011) in his recent study for the same genotype as he found no significant effect of calving year on this trait. But the result is in the line of the literatures reviewed by Parra-Bracamonte *et al.* (2005), Ageeb and Hillers (1991a) and Habib *et al.* (2010) who noticed significant ($p<0.05$) difference of daily milk yield among different years. The reversible results found between studies within same genotype could have derived for number of sample size taken for analyses. The variations of daily milk yield that existed among different years of this study could usually be due to changes in management, feeding regime and other environmental factors experienced by the cows.

Calving season caused significant ($p<0.05$) effect for daily milk yield of RCC (Table 1). The result is in consistent with Habib (2011) for RCC and Darfour-Oduro *et al.* (2010) for Sanga and its crosses with Friesian cattle in Ghana who reported significant ($p<0.05$) effect of calving season on daily milk yield. However, in contrast, Habib *et al.* (2010) for RCC, Parra-Bracamonte *et al.* (2005) in Mexico and Ageeb and Hillers (1991a) for Kenana and Butana cattle in Sudan noticed reverse effect ($p>0.05$) on this factor. Habib (2011) stated that this variation of daily milk yield in cows that calved different seasons could be attributed due to availability of feed in that period which puts the animal in good condition for milk yield.

Heritability of lactation length

The heritability of lactation length was estimated as 0.04±0.05 (Table 2) which is within very low level of estimates. This is in the line of those findings ranged from 0 to 0.09 (Habib, 2011; Ageeb and Hillers, 1991a) for different breeds of cattle. However, Alam *et al.* (2007) and Munim *et al.* (2006) reported heritability estimates of 0.39±0.16 and 0.41±0.15 for RCC which are medium value of estimates. The low estimate of heritability for this trait

Table (3): Genetic (below the diagonal) and phenotypic (above the diagonal) correlations among milk yield traits

	Lactation length	Lactation milk yield	Daily milk yield
Lactation length	1	0.63**±0.06	0.12*±0.06
Lactation milk yield	0.81±0.13	1	0.83**±0.06
Daily milk yield	0.99±0.14	0.73±0.12	1

*-significant at 5% level (p<0.05); **-significant at 1% level (p<0.01)

does not mean the chance of improvement for selecting animal on the basis of its own phenotypic performance, because environment largely contribute for variations of that trait rather than genetic. Though major role of variation in lactation length was due to non-genetic factors, hence rapid response could be expected by improving environmental conditions such as feeding regime, management system, disease control etc. Crossbreeding might be another option for improving of this trait.

Heritability of lactation milk yield

The heritability of total lactation milk yield (Table 2) was found as medium (0.23**±**0.05) which is closely in the line of medium range (0.30 to 0.40) as reported by Warwick and Legates (1979). This result is also accorded to 0.27±0.11 found by Alam *et al.* (2007) for same genotype. However, this result is not consistent with the earlier works of Habib (2011) and Munim *et al.* (2006) for the same genotype as they found higher level of estimates (0.54±0.06 and 0.59±0.04, respectively). The low estimate of standard error of heritability for this trait implies that this result may reliable source for future reference, however, the differences between this study with others for the same genotype could be explained by environmental changes from which the individuals were considered for analyses, sample size, genetic constitution of the population from which sample were taken, methods of analysis etc. The medium value of heritability for total lactation milk yield found in this study implies the chance of further improvement of this trait by selecting animal based on individual's own phenotypic performance.

Heritability of daily milk yield

The heritability of daily milk yield (Table 2) in this study (0.34±0.06) coincides by the recent findings of 0.32±0.07 obtained by Habib (2011) for the same genotype. Warwick and Legates (1979) in their publication reported the daily milk yield as a medium heritable trait. Munim *et al.* (2006), Taneja and Bhatnagar (1985) and Das *et al.* (2003) found heritability for this trait ranging from 0.33 to 0.43 for RCC and different type of pure and crossbred cattle. Their results came in to agreement with this study. On the other hand Ageeb and Hillers (1991b) found 0.68±0.30 for Friesian×Butana and Friesian×Kenana cattle which was higher than this study. The magnitudes of the heritability for this trait found from different published literatures might be varied due to different genotype, sample size or method of data analyses. The medium estimates of heritability for daily milk yield indicates the chance of improvement for this trait in the next generation if selection is based on individual's own phenotypic value and mass selection as well. The result found in this study might be used as future reference as indicated by lower estimate of standard error.

Phenotypic and genetic correlations among milk yield traits

Table 3 shows that the phenotypic and genetic correlations of lactation length with lactation milk yield and daily milk yield were all positive and significant (0.63** and 0.81 and 0.12* and 0.99, respectively). Singh and Blaine (1971) reported that lactation length had a highly significant positive phenotypic correlation (0.58) and a large positive genetic correlation (0.79) with lactation yield which perfectly agrees with this study. Cilek (2009) reported highly significant phenotypic correlation (0.39***) between lactation length and lactation milk yield. Rahman *et al.* (2008) in their studies reported phenotypic and genetic correlations of 0.30 and 0.40 between the same traits. Their results are in agreement with this study.

Again, the phenotypic and genetic correlations between total lactation milk yield and daily milk yield were positive and highly significant (0.83** and 0.73, respectively). The difference of magnitude of correlations among studies might be due to different breed, sample size or method of analysis. The results of correlation study among milk yield traits indicate that same gene is responsible for controlling of those traits. Further, positive relationship among traits revealed about the favorable direction, hence, may have opportunity to improve more than one trait simultaneously when selection is based for single trait. So, efforts to take advantage for total milk production will ultimately cause improvement for other traits as correlated response.

CONCLUSION

Finally, it could be concluded that RCC has promising inheritance to explore its genetic potentiality for milk production for further improvement if proper selection and breeding is applied through systematic way.

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